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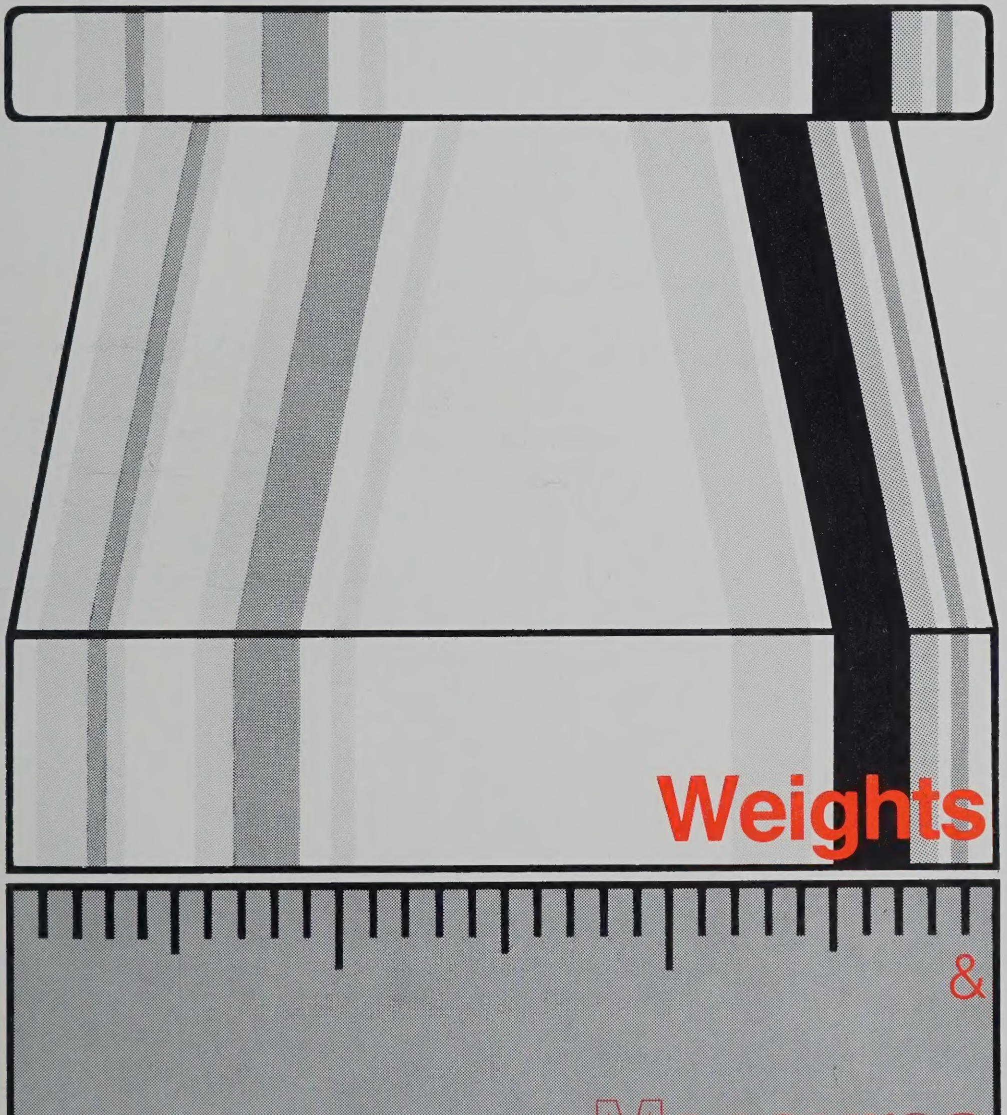
DIMENSIONS NBS



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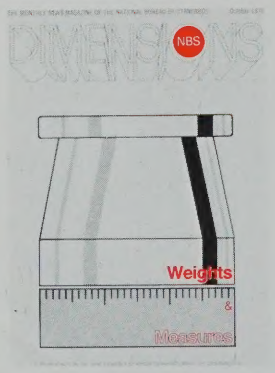

Cover: Since 1907 NBS has assisted the states in assuring equity in the marketplace through fair weighing and measuring practices. See story beginning on opposite page.

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The Institute for Materials Rsearch
The Institute for Applied Technology
The Institute for Computer Sciences and Technology
Center for Radiation Research
Center for Building Technology
Center for Consumer Product Technology
Center for Fire Research

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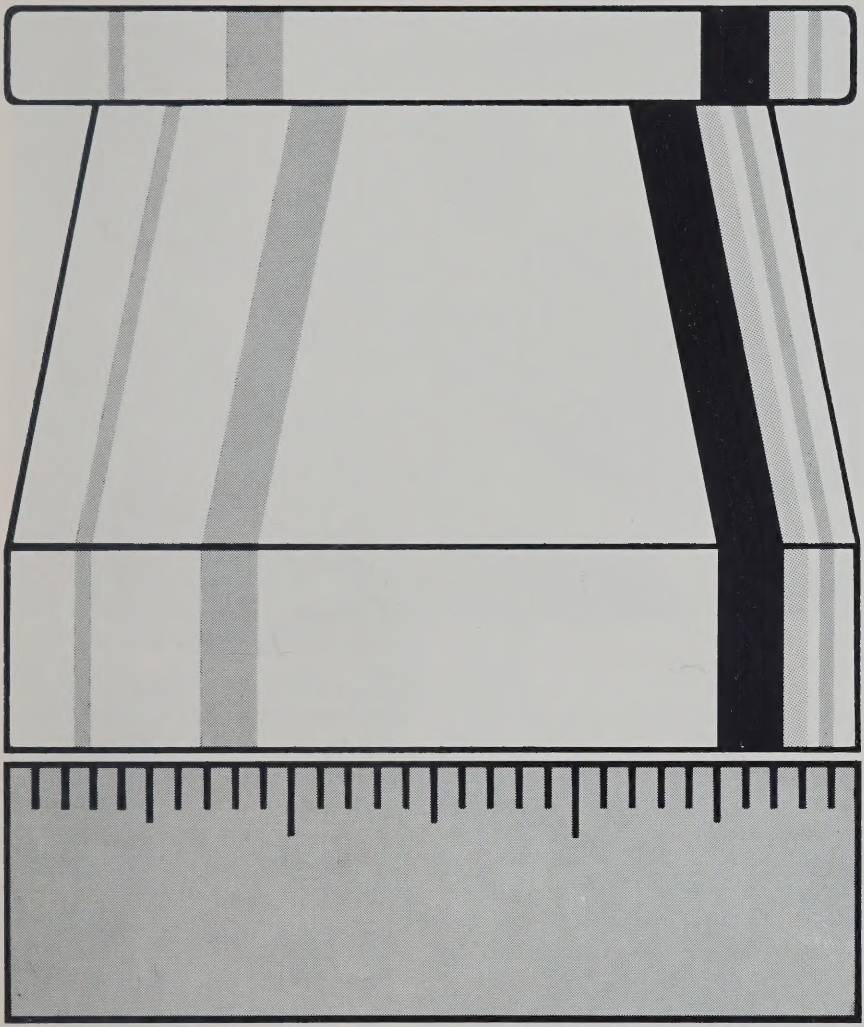
Weights & Measures

New Challenges in Today's Marketplace

by Ernest Ambler



Dr. Ambler, acting director of the National Bureau of Standards, addressed the 61st National Conference on Weights and Measures (NCWM) on July 14, 1976. NCWM, established in 1905 by the first NBS director, is an annual forum for state and local weights and measures officials and NBS representatives. Participants develop policies and model regulations to assure equity in the marketplace.

The following is an excerpt from Dr. Ambler's speech.

"The relation between standards and the regulation and inspection of weights and measures used in commerce is so important that cooperation between the officials having these matters in charge is absolutely essential to secure uniform, efficient results. It was for this purpose that the various state custodians, inspectors, and sealers were invited to meet with the officials of the National Bureau of Standards. As the representative of that institution, it gives me great pleasure to welcome you to this conference, which cannot fail to be productive of the utmost good."

These words were spoken by Dr. Samuel Stratton, the director of NBS, in welcoming officials to the first National Meeting of Weights and Measures in 1905. In this, my first address as president of the National Conference, I chose to repeat Stratton's words because the need for cooperative interaction is equally important today. Furthermore, I feel as personally committed to the goals of this organization as did Stratton in those fledgling days.

When we look at today's environment, we see an increasingly complex society. It is a complexity which continues to grow proportionately with the product of such multipliers as increased urbanization and the many by-products of industrial production. This complexity is manifest in such issues as energy conservation, environmental protection, and materials shortage, which all directly affect today's citizen and his activities in the marketplace. As the effort and time necessary to meet these challenges increase, we find the citizen losing confidence in institutions.

We speak of the erosion of confidence in government, the erosion of confidence in industry. In pursuing this notion, it is my fear that we may be losing confidence in ourselves. After all, each of us works directly or indirectly for government or industry, and, collectively, we are the public. Thus we are faced with the challenge of restoring confidence in ourselves

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and in each other in a complex environment.

Assessment

Those of us involved in assuring fair practices in the marketplace must first assess where we stand today. We have reliable standards, well-equipped laboratories, qualified and trained personnel, model laws to assure uniformity, and this conference that provides the forum for uniformity. However, no solutions are absolute. Rather, we strive for progressive adjustment.

There are three matters that must be considered in any plans we make for the future: metrication, the rapid development of new technologies, and the concerns of the consumer.

Weights and measures standards provide the language of communication between buyer and seller. Just as the delegates to the 1905 meeting were concerned with developing the language of customary standards, we must begin to provide the metric language so necessary for economic communication.

Our nation is now committed to voluntary metric conversion, and as Malcolm O'Hagan (President, American National Metric Council) has noted, the climate for conversion is greatly improved by the European community's requirements to use SI units in trade and commerce throughout the common market and by the realities of international trade in a metric world.

Minimizing Misunderstanding

A primary objective of our conference today, and in the months to come, should be the development of basic tools for metric communication between buyer and seller. We can help minimize public misunderstanding about metric conversion and we can minimize the potential for mistrust between the affected public and the government. By doing so, I think we can help restore the eroded confidence in both government and industry. The net result will be increased self-confidence in our ability to govern ourselves.

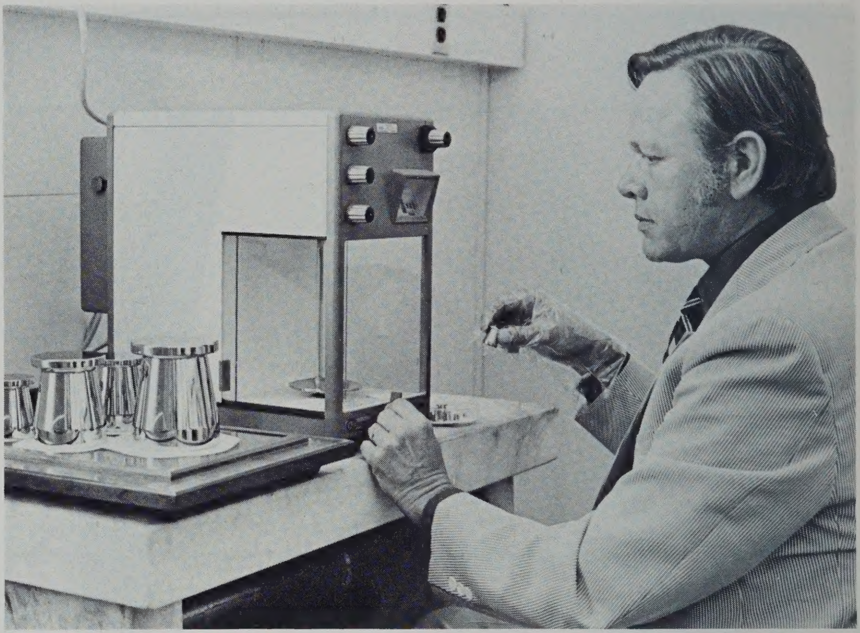
NBS will make full use of our available resources to assist in meeting the immediate metrication demands that will fall on state weights and measures officials. In accord with our responsibilities under the Metric Act of 1975, NBS metric information facilities will be devoted more fully to metric needs in weights and measures.

The NBS Office of Weights and Measures has, with the support of the United States Office of Education, recently conducted a series of seminars on metric conversion for weights and measures officials across the United States. A purpose of these seminars is to educate a core group of officials who can serve their own jurisdictions as instructors in metric training.

OIML

I am sure the efficient transition to metric will be aided by explicit attention to coordination with domestic and international standards-setting institutions. I hope that this conference through its new Committee on Policy and Coordination will give due consideration to the metric recommendations originating in the International Organization for Legal Metrology (OIML). When and where they have U.S. approval, the adoption of OIML metric recommendations would provide an important advantage to

(Photos by Mark Helfer.)



Harold Wollin, chief of the Office of Weights and Measures, works with new standards that NBS is supplying to the states.

A Maryland state weights and measures inspector tests the accuracy of a check-out counter scale. The weights he is using are calibrated against the standards produced by NBS and given to the state of Maryland.

our industry and commerce.

The activities of OIML are much more extensive than metrication. Since the U.S. joined OIML, NBS has attempted to assure that OIML positions truly reflect a representative national response. Through the Advisory Committee for International Legal Metrology, chartered in 1974, U.S. representatives include more than a dozen governmental and private sector institutions. This conference has been an active representative to the Advisory Committee. Input from NCWM is indispensable if we are to adopt international positions that are in the best interests of the U.S.

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New Technologies

I also mentioned the issue of rapidly developing technologies. The impact of new technologies affects a broad spectrum of weights and measures activities. The examples are numerous:

- Interfaces between scale, cash register, and computer.
- In-motion weighing of transportation vehicles.
- New readout devices for fluid and time metering.
- Application of digital electronics to truck weighing and railroad scales.

The important point is that each of these new developments involves a change in the functioning of our measurement system. Each changeover poses a challenge for intergovernmental cooperation. We must work in concert with these new technologies. We must assure the public that applications of new technologies in the marketplace will be responsive to their needs.

This brings me to the third issue—that of consumer concerns. In characterizing the attitude of consumers, Commerce Secretary Elliot Richardson states that the private citizen desires "the right to grant or withhold 'consent of the governed' not only as a voter, but as a consumer, as an employee, as a taxpayer, as a woman, as a black . . . the right to an *informed choice* at the ballot box *and* in the marketplace."

NBS and the Consumer

At NBS we are engaged in a variety of consumer-related activities. Some of these involve the development of standards and instrumentation to ensure the health and safety of the consumer when he uses such diverse products as bicycles, lawn mowers, hearing aids, and others. We are developing standards for home security devices—locks and burglar alarms.

The Bureau's Center for Consumer Product Technology is engaged in programs to develop standards and uniform test methods for measuring the performance and safety characteristics of consumer products. This work ultimately provides the consumer with information about individual product characteristics at the point of purchase. Closely related is our work for the Federal Energy Administration on standards for labeling appliances with respect to their energy consumption.

Of importance to weights and measures interests are some of our Consumer Information Series publications. For example, we are now preparing "Automation in the Marketplace," which indicates to the consumer the impacts of electronic funds transfer, the universal product code, and direct point-of-sale readouts in retailing.

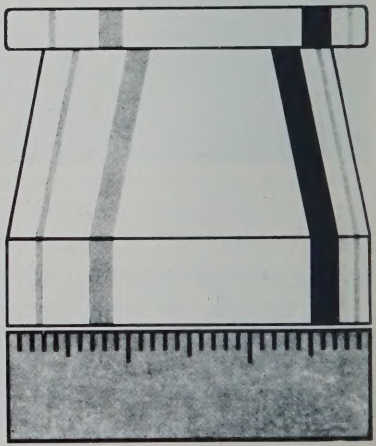
Less Confusion

A prime objective of all these efforts is to provide the consumer with information. In turn, this helps industry by reducing the number of needless complaints based on ignorance or poor information. It should also help weights and measures officials in their dealings with both industry and the public by minimizing confusion.

Therefore, we have metrication, the rapid applications of new technology, and consumer concerns—three major trends that will affect the future actions of the NBS-NCWM partnership.

Because of the growing importance of the consumer as an economic and political force, we at NBS are reviewing our priorities for utilizing our resources. We have identified a need to re-evaluate our own role in weights and measures. This will require an examination of the whole system of weights and measures and the roles of all participants. I suggest that you join us in this activity through re-evaluation of your priorities in light of your available resources. It will be of inestimable value to the Bureau to have your assistance and guidance in delineating the priority needs of the states.

This then is our goal for the immediate future: To establish our priorities in weights and measures for the best utilization of our available resources. Our strength and our goals lie in anticipating society's demands and in providing services which make a difference. I expect the NBS-NCWM partnership to continue as an effective and responsive mechanism for providing those services. ☐



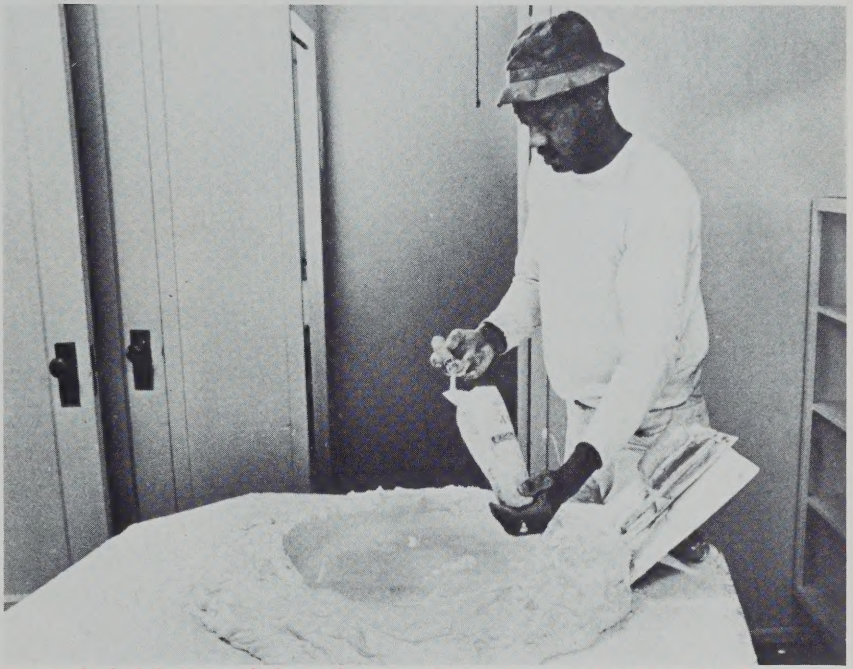
The Money Side of the Lead Paint Problem

by Frederick P. McGehan
NBS public information specialist

Poorly maintained older homes, mainly located in the nation's inner cities, present a unique health hazard. Small children living in these homes may become ill from eating chips and flakes of lead-based paint.* In some cases, the paint peels from walls and ceilings. In other instances, children scrape chips from doors and woodwork.

One solution, obviously, is to eliminate the hazard by removing or applying covering materials to the lead painted surfaces. That responsibility rests ultimately with housing owners, whether they are individuals who occupy the homes, landlords with small holdings or even public landlords—like the federal government. The common aim of these homeowners is to find the least expensive yet most effective means of preventing access to lead paint.

The National Bureau of Standards has assisted the Department of Housing and Urban Development (HUD) under HUD's Experimental Hazard Elimination Program (EHEP) to identify the most effective lead paint hazard abatement techniques and to prepare cost models for these methods.



One method of dealing with the lead paint problem is to cover the old paint with a material thick enough or hard enough to prevent children from coming in contact with paint chips or dust. Here a workman prepares a mixture of gypsum veneer plaster and water to coat an old painted plaster wall.

Data Collected

To begin with, 110 housing units in Washington, D.C., and Atlanta, Ga., were "deleaded" in the EHEP demonstration program using a variety of abatement materials and techniques. Cost data were collected on each of the methods and analyzed by researchers in the NBS Center for Building Technology.

Prior to this analysis, explains Robert E. Chapman, an operations research analyst with the Bureau's Building Economics Section, there were virtually no objective cost data available to officials responsible for programs to eliminate this hazard. Estimates were commonly arrived at by "eyeballing" the job to be performed.

A cost model, Chapman says, "allows homeowners, contractors and housing officials to get a more precise estimate of the cost." It enables them to predict the cost of labor and materials—depending on the deleading method chosen. Having a cost model helps policy makers or program managers to allocate their lead paint abatement budget most efficiently. Chapman was assisted in his study by Joseph G. Kowalski, an economist in the Building Economics Section.

Developing Cost Models

To develop their cost models, the NBS researchers examined each technique according to the building component being worked on, such as walls, doors and frames, windows and frames, and miscellaneous trim. From this they obtained a per-unit direct cost (per square foot, per item, or per linear foot). The various techniques were then ranked according to their per-unit direct costs.

For example, nine different techniques were used to cover up lead paint on walls. In some cases loose paint had to be scraped away before

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* Ingesting lead-based paint may not be the leading cause of lead poisoning, a household survey in Pittsburgh, Pa., indicates. See last month's DIMENSIONS/NBS for details.

PAINT *continued*

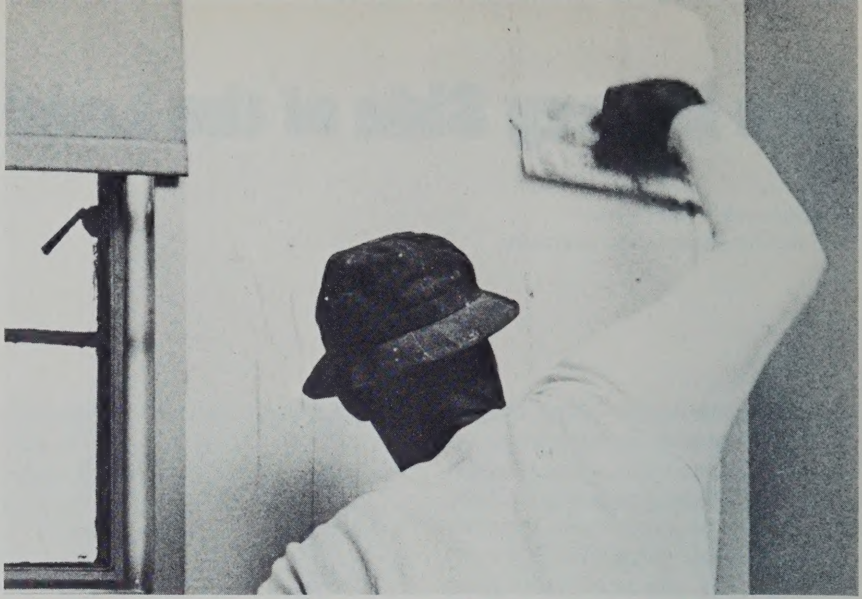
a new coating was applied. In other instances, a new surface, such as wallboard, could be installed without preparation work. The average per-unit direct costs varied considerably. A cement-like coating had the lowest direct cost per square foot (including paint removal)—20 cents. Prices escalated from there: aggregate filled paint, 21 cents; vinyl-coated fabric, 49 cents; veneer plaster, 74 cents; gypsum impregnated fiberglass fabric, 77 cents; gypsum impregnated jute fabric, 79 cents; gypsum wallboard, 92 cents; plaster with lath, $1.31; and melamine paneling, $1.65. It is important to recognize that these costs do not represent abatement techniques of equal performance. The less costly materials may not be as durable as the more expensive wallboards and paneling. There are differences in the effectiveness of the techniques at preventing children from coming into contact with the lead paint which remains beneath the barrier. These last two points touch on another problem, and that is how to estimate the potential benefits associated with a particular abatement technique. Although this information is important in developing a comprehensive approach to lead paint abatement, it should be emphasized that the knowledge of direct costs provided by the cost models is crucial to decision makers faced with the lead paint problem here and now.

Techniques Categorized

The techniques were then categorized according to average direct costs. In the case of walls, the cement-like coating and aggregate filled paint were least expensive (i.e., in category 1); veneer plaster, gypsum impregnated fiberglass fabric, gypsum impregnated jute fabric and gypsum wallboard were in category 2; plaster with lath was in category 3; and melamine paneling, the most expensive, was in category 4. Cost models were then developed for each category so that analysts could predict the costs of using any of the techniques in those categories. Taken into account in the cost models were variations in per-unit direct cost caused by differences in surface areas to be treated, prevailing wage rates, and the amount of time required for one technique as compared to others.

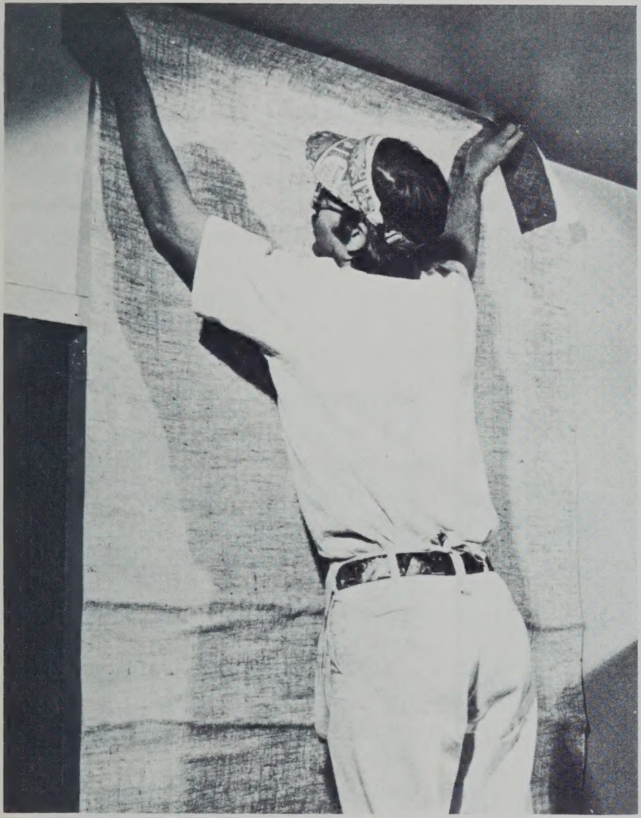
"Most of the cost models may be used with confidence in most regions of the nation . . . by decision makers to estimate the direct costs of lead-based paint abatement," states Chapman in an upcoming NBS Technical Note, "Economic Analysis of Experimental Lead Paint Abatement Methods: Phase I."

Additional cost data are currently being collected in Boston, Mass., under a second phase of the Experimental Hazard Elimination Program. Researchers will analyze these data in an attempt to answer questions concern-

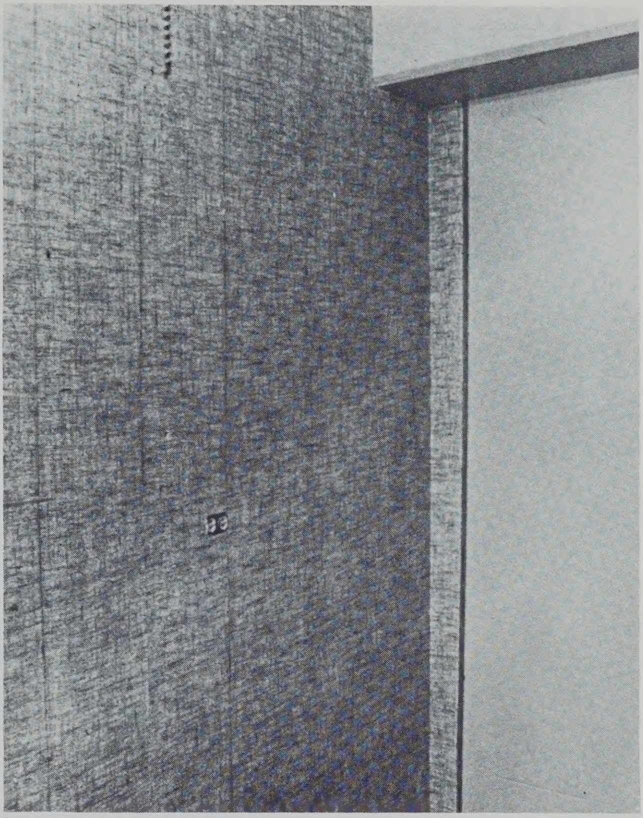


Unlike ordinary plaster that is applied over wooden laths or wire mesh, this gypsum veneer plaster sticks directly to the old wall material, building up about 3 mm of new plaster over the lead-based paint.

Another solution to the lead paint problem is gypsum jute wall covering, which is applied to the old painted surface like wallpaper. Here, a workman applies a latex-based aqueous adhesive to a sheet of jute fabric which has been impregnated with gypsum.



The gypsum jute wall covering is applied after the old surface has been scraped to remove loose paint chips and covered with a bonding material. The gypsum in the fabric absorbs water from the adhesive and the air and hardens in the fabric.



The finished product—a kitchen wall covered with gypsum impregnated jute fabric. The hardened gypsum makes the wall covering much harder and more rigid than a similar thickness of wallpaper.

ing differences in costs for publicly owned properties in contrast to those that are privately owned. Allowances will be made for inflation, profit, and overhead-markups in determining the unit cost. Emphasis is also being placed on developing a reliable procedure for estimating the potential benefits which lead paint abatement carries.

Implications

The anticipated use of the cost models and associated cost-estimating procedures should result in significant savings to building owners. Their use will allow the least-cost abatement method to be identified for the degree of durability and effectiveness required which will permit more abatement per dollar to be achieved. Large property owners, such as federal and local governments, can then plan their lead paint abatement programs more efficiently. Cost-effective administration of such programs will also save scarce tax dollars.

Finally, the use of such a cost model will aid in the establishment of priorities as to when and where abatement is to take place, so that the maximum reduction in the rate at which lead paint associated injuries occur per dollar spent can be achieved.

Researchers in the Building Economics Section hope to package their information in an easy-to-use handbook that describes how savings to consumers can be maximized. In discussions with government officials, building owners, and renovation contractors, a common conclusion is that such a handbook would reduce risks and stimulate competition in the rehabilitation sector. □

The Consumer Comes Face-to-Face With the COMPUTER

by Zane Thornton*

(Photos by Mark Helfer.)

This computer terminal permits bank transactions 24 hours a day. The customer can withdraw cash, make deposits, and transfer funds between accounts.

Last month in DIMENSIONS/NBS Zane Thornton discussed the new breed of computer systems now being introduced in the retail and grocery industries. The following article completes that discussion by explaining the systems that handle funds in banks and other businesses.

GERTRUDE Stein once said that money is always there but the pockets change. Moving money from pocket to pocket, or from account to account, is a gigantic task. Consider these figures (from the National Science Foundation Report C-76397, January 30, 1975) concerning the American economy:

- 250 billion financial transactions are carried out annually.
- 27 billion checks were written in 1973. Processing these checks cost the banking industry $5 billion, with a total cost to society of $10 billion.
- 20-25% of Americans carry bank credit cards, with a total of over 35 million card-related accounts.
- 16% of retail sales involve credit cards.
- $45 million is spent annually to manufacture money. $90 million is devoted to armored car operations and $430 million goes to protection agencies.

In short, the money game is a complex and expensive operation, and there is great interest in streamlining the payment system. Solutions based on electronic funds transfer (EFT) offer vast potential in this field, pro-

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* Zane Thornton is deputy director of the NBS Institute for Computer Sciences and Technology.

Part II The New Money Handlers—Electronic Funds Transfer Systems

viding the financial, technological, regulatory, and social issues can be sorted out.

Would widespread use of EFT mean that the "cashless/checkless society" predicted by some people a few years ago would become reality? No, but we would most certainly become a "less cash/less check society." Personally, I hope that term is just a shorthand notation for a better way of doing business, and not a reflection of my own balance sheet.

Let me give some examples of EFT, and some potential problems as well. Your salary could be paid by a system that automatically debits your employer's account and transfers the salary to your personal bank account. The federal government, one of the nation's largest checkwriters, is already moving in this direction. The Social Security Administration, which issues nearly 43.5 million payments worth $7.8 billion per month, is automating its payments, and other Federal recurring payrolls are expected to follow.

The consumer may also encounter EFT in the department store and supermarket. In this mode, you could pay for purchases by authorizing an on-the-spot transfer of funds from your personal checking account to the retailer's account at a local bank.

Another approach—the buck passer or customer-bank communications terminal—involves direct operation. First you would initiate a transaction by inserting an identity card and entering a secret code number or pass word. Once "on-line," you could then withdraw cash, make a deposit, or transfer funds between accounts. Instructions displayed on a screen at the terminal would guide you through the transaction, and a receipt—plus cash if the operation involved withdrawal—would be provided automatically.

Finally, a pre-authorized debits arrangement could be used to pay recurrent bills. You would simply authorize the bank to debit your checking account at specified intervals by specific amounts and to transfer these funds to other accounts. Such transactions are already being used in the areas of deductions for savings accounts and savings bonds, and payment of bills for insurance and loans. Again, no check would be written and a permanent record would be created.

The EFT arena is cluttered with problems ranging from financial regulatory issues to the impact that EFT systems will have on the consumer's lifestyle. Some possible EFT impacts are discussed in an Arthur D. Little, Inc., report.[*]

The report points out that the high, middle and low socio-economic-status groups each have traditional and different patterns of handling income checks, using bank accounts, and methods of making payments. For those consumers who don't regularly use bank accounts or pre-authorized payments, EFT systems may pose some major problems in lifestyle adjustment. At the same time, EFT systems may be a boon for those consumers who are already making extensive use of bank and credit cards, pre-authorized payments, and direct deposit of income checks.

Some people are significantly concerned about the impact that EFT systems may have on the privacy of individuals. For example, the A. D. Little report states that the government, acting for accepted social purposes such as detecting tax evasion and improper claims of welfare payments, might seek access to electronic payment records. The ease with which EFT systems can collect, store and aggregate data may make the individual more vulnerable to invasion of financial privacy than current payment methods.

Welfare rights advocates fear that compulsory deposits of welfare checks, coupled with requirements for certain pre-authorized payments and other EFT records, could be used to regulate how welfare recipients spend their payments.

Finally, aside from the individual privacy issue, there is considerable concern about the security of EFT systems. Some authorities have already warned that EFT systems may offer the criminal element a new technique for counterfeiting or stealing money. We already know, for example, that our computer systems are not secure; Steve Lipner, MITRE Corporation, has reported that a recent study of financial fraud using computers shows that for about 300 cases the average loss was nearly $500,000 each. In order to protect electronic funds, it is clear that great emphasis will have to be placed on methods for positively identifying people trying to access EFT systems, and on techniques for protecting data in storage in computer systems or being electronically transmitted between computer systems.

The computer security program at NBS is a major source of standards, guidelines and techniques for pro-

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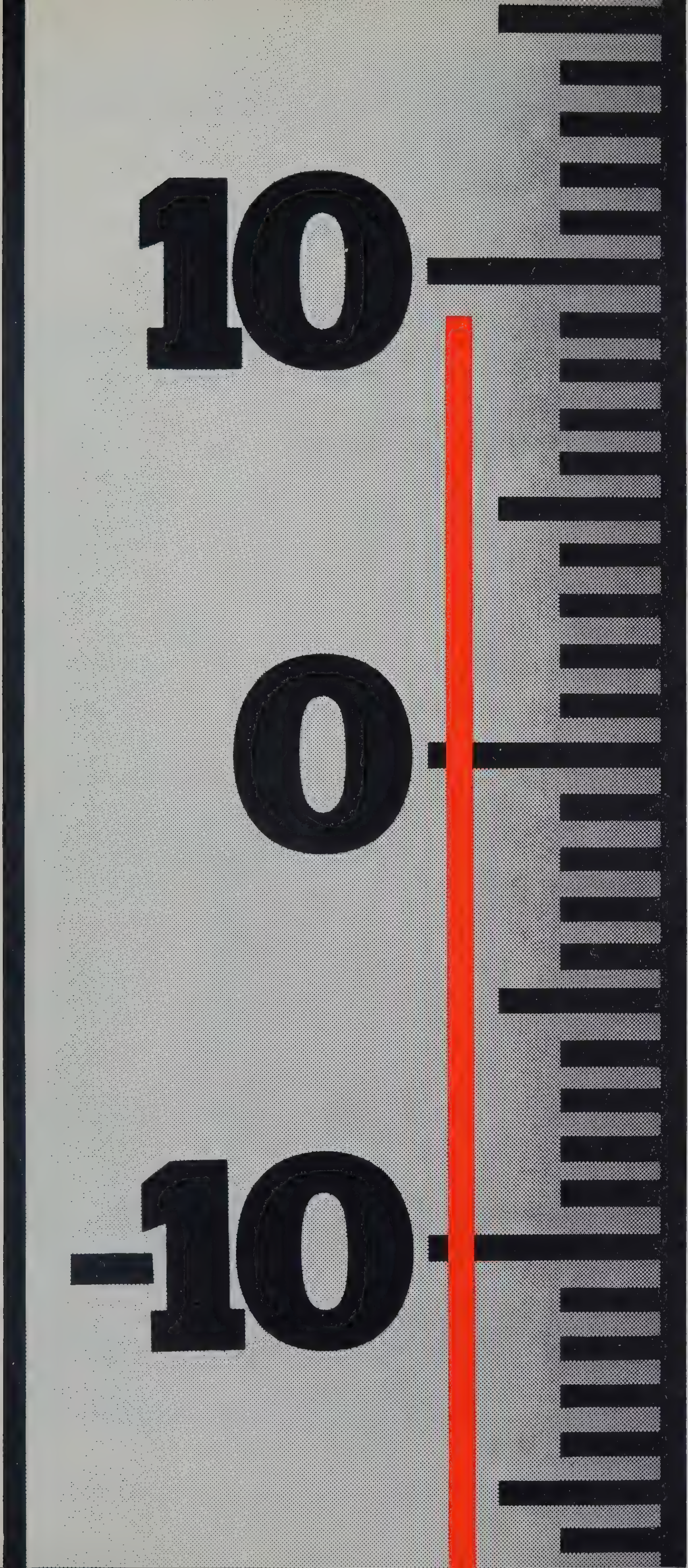
[*] *The Consequences of Electronic Funds Transfer—A Technology Assessment Of Movement Towards a Less Cash/Less Check Society*, January 30, 1975, prepared for the National Science Foundation.

What appears to be a telephone is actually much more. It is also a computer terminal located in a small branch office of a large metropolitan bank. By dialing certain codes, the teller can connect directly with the bank's main computer to get information on balances, deposits, and withdrawals on savings or checking accounts. Incidentally, the computer answers the coded requests in English.

tecting computer systems and networks and controlling access to them, and for safeguarding sensitive data. The Bureau's work in the areas of data encryption algorithms and such personal identification techniques as fingerprints and voiceprints certainly has application to the EFT security problem.

While it is interesting to speculate about the merits of electronic point-of-sale terminals, automated supermarket checkstands and electronic fund transfer systems, this speculation must be tempered with a liberal amount of cold reality. Because we have never before tried to bring the consumer into such close contact with the computer on a broad scale, we don't know the extent to which we may be fomenting a hot confrontation. There are many complex regulatory, technological, economic, and societal problems yet to be resolved in the EFT area alone. These problems are not likely to be solved quickly; it may be another 1½ years before the National Commission on Electronic Fund Transfer will report its findings to the Congress.

One point is certain—both the businessman and the technologist will develop new insights as they design and use the new breed of computer systems that interact directly with the consumer. In turn, the consumer may find new ways to make his presence felt in the board rooms and laboratories where decisions are made regarding the use of technology. If the businessman and the technologist learn to work intelligently with the consumer, they might find the consumer opening the door to the backroom the next time a computer system is ready to move to the front lines. ☐



A Primer on Temperature Scales

Centigrade/Celsius,
Fahrenheit,
Kelvin

*by James F. Schooley**

AS the metric system comes into increasing use in the United States, the National Bureau of Standards is often requested to explain the difference between temperature in "degrees Centigrade," and "degrees Celsius." In addition, there is renewed interest in the proper relationships between the scientific temperature scales (Celsius and Kelvin) and the familiar Fahrenheit system. Here by way of explanation is a thumbnail sketch of the history of temperature measurement.

Our present variety of scales dates back to the early 1700's and the beginning of modern temperature measurement. Then there were roughly as many scales as there were people who knew how to measure. Among them were Gabriel Fahrenheit, a Pole; Anders Celsius, a Swede; and, later on, Lord Kelvin (W. Thomson), a Briton.

Fahrenheit, who invented the mercury thermometer, based "zero" on the lowest temperature he could ob-

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* Dr. Schooley is chief of the NBS Temperature Section, Institute for Basic Standards.

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tain with a mixture of salt and ice, which turned out to be 32 degrees (Fahrenheit) below the freezing point of water. As a second reference point, he picked the blood temperature of the human body and then divided the distance between these two points into 96 degrees. (Actually blood temperature is two to three degrees higher than Fahrenheit reckoned, but inaccuracies in his original instruments caused this discrepancy.)

Celsius, meanwhile, developed a scale defined by the freezing and boiling points of pure water at sea level. Since he divided the space between these two points into 100 degrees, the scale was called "Centigrade."

In 1927, the multi-nation General Conference on Weights and Measures defined an International Temperature Scale which was, in fact, the Centigrade System. In the meantime, the Fahrenheit scale had come into common use in England and the United States.

Centigrade became Celsius at the 1948 meeting of the General Conference, a difference in name only. The principal reasons for the change were a desire for uniformity (in some parts of Europe it was already called "Celsius") and a desire to honor the originator of the scale.

The Celsius Scale changed in 1960 when the General Conference redefined the scientific temperature scale (by this time called the "International Practical Temperature Scale") by naming two new reference points. Instead of the freezing and boiling points of water, absolute zero and the triple point temperature of water were chosen to define the scale. The absolute zero of temperature (the point at which a substance contains no heat energy) was designated as −273.15 °C. The triple point of water, which marks the equilbrium between the vapor, liquid, and solid states of water, occurs only at an extremely precise pressure and temperature, that temperature being 0.01 °C.

The change is meaningful only to the "experts," since, to a close approximation, water at sea level still freezes at 0 °C. and boils at 100 °C. But from the scientific point of view the old "Centigrade" designation is not accurate and therefore the name "Celsius" is more satisfying.

In order to make calculations with temperatures, a scale which has no negative numbers is often useful. The so-called "Kelvin Thermodynamic Scale," named for its originator, Lord Kelvin, evolved to meet this need. (It is now officially called "thermodynamic temperature.") The basic unit is the kelvin (there is no "degree Kelvin") and the absolute zero of temperature is defined as 0 kelvins.

As the United States adopts the metric system, the Celsius scale will become the common language of temperature for Americans. Remember, in Celsius normal body temperature is 37 degrees—and 25 degrees will never make a cold day, even in July.

If you wish to pursue the subject of temperature further, most library references and encyclopedias written since 1970 can be considered current. Also, coming issues of DIMENSIONS/NBS will contain more detailed discussions of temperature measurement. For technical information, write to the Temperature Section, National Bureau of Standards, Washington, DC 20234. □

WHAT'S THAT IN FAHRENHEIT?

Today, there are three temperature scales used in the United States: Fahrenheit, which is being phased out; Celsius, the metric scale in use throughout the world; and Kelvin, a scale which contains no negative numbers and is therefore useful in scientific calculations.

	Fahrenheit (°F)	Celsius (°C)	Kelvin (K)
Absolute zero	−459.67	−273.15	0
A "cold day"	0	− 17.78	255.37
Freezing water	32	0	273.15
Water triple point	32.018	0.01	273.16
Average room temperature	70	21.11	294.26
Body temperature	98.6	37.00	310.15
Boiling water	212	100.00	373.15

degrees Celsius (°C) = kelvins −273.15 (A degree Celsius and a kelvin represent the same *interval* of temperature.)

degrees Fahrenheit (°F) = 9/5 (degrees Celsius) + 32.

Monitoring the Exchange of Power

New Calibration System for Electrical Industries

by Madeleine Jacobs
NBS public information specialist

CAN you imagine a world without electricity? Probably not. But, despite its important place in the total energy picture, electricity is not a *source* of energy. Rather the importance of electrical energy is that it's the nearest thing we have to a universal *medium* of energy exchange.

Other energy forms are readily transformed into electricity and electricity, in turn, is easily changed back into mechanical energy, chemical energy, and into heat and light for homes, office buildings, shopping centers, and factories.

Today, vast networks of power lines reach into all parts of the United States with tie-lines connecting one local or regional network with another. Large exchanges of electricity over these lines—such as frequently occur during summer or winter months when there is a greater increase in demand for electricity in one region than in another—are monitored by on-line measuring devices that relay their readings to central points where the information is processed. Accuracy in these measurements is obviously indispensable for reliable and economical operation of the system.

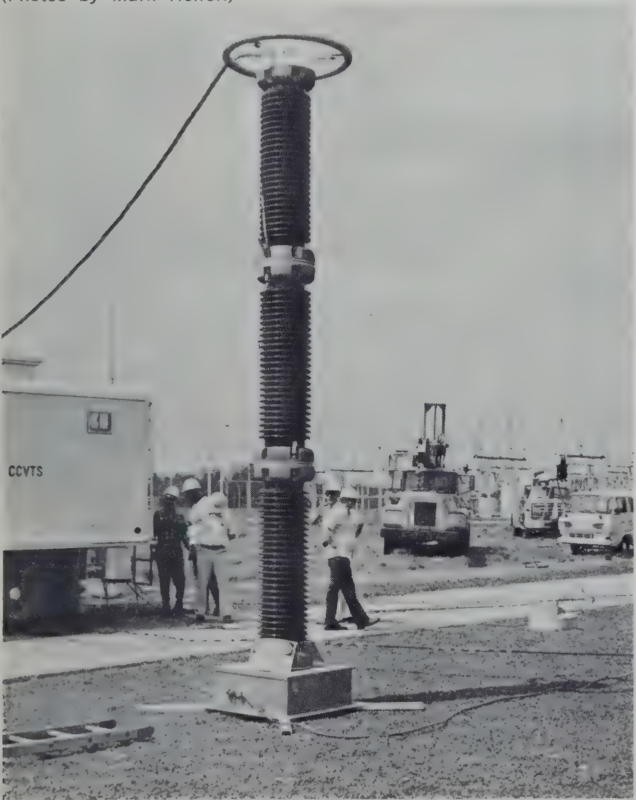
Exchange of Power

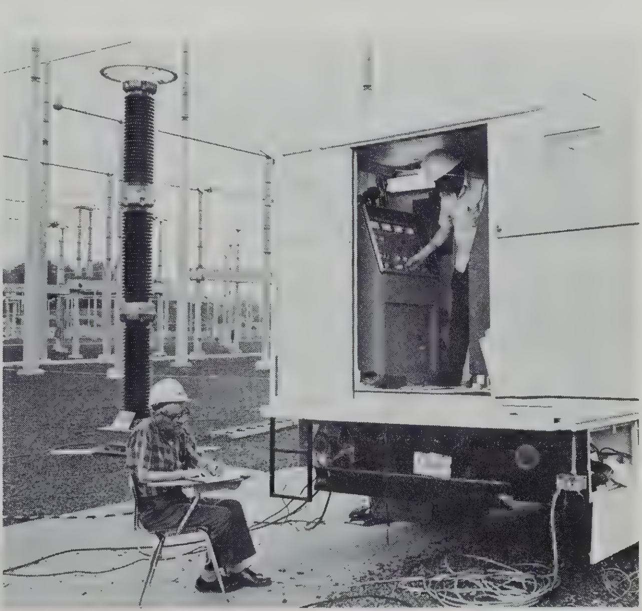
"The electrical utilities must have precise metering for another reason," explains engineer David L. Hillhouse of the NBS High Voltage Measurements Section. "During a routine or emergency exchange of power between utilities, a great deal of money is involved. The utilities need to know exactly how much energy was bought and sold."

For example, he points out that there are existing extra high voltage (EHV) transmission lines between utility companies that transfer energy worth $10,000 an hour or more. "An uncorrected 0.5 percent error in the devices that are metering these lines represents an inequity of more than $400,000 a year," he notes. And, of

turn page

(Photos by Mark Helfer.)





The new field calibration system is set up at the BG&E Waugh Chapel, Md., substation for preliminary calibration of the high voltage transfer standard divider (foreground). The NBS-EPRI truck contains a resonant power supply and bridge for calibration (left).

NBS technician Walter J. Mangan and project leader David L. Hillhouse (seated) calibrate high voltage transfer standard divider at 100 kilovolts (kV) prior to placing it on the 500 kV substation line. The 500 kV substation buses are in the background.

course, higher energy costs of utilities are often passed on to consumers.

Accuracy Required

But how do you insure that this metering is accurate? Since it is not feasible at the high voltages found on transmission lines to measure electrical energy flow directly with a watthour meter like those used in homes, the voltage is first "stepped down" with a potential transformer (PT). Sometimes two or more transformers "in cascade" (in sequence) are needed to bring the voltage down to the operating range of available meters. Inductive-type transformers are the most frequently used, basically consisting of a primary input coil and a secondary output coil wound on a common magnetic core.

Increasingly favored for reducing voltage is the coupling capacitor voltage transformer—or CCVT—which is a group of high voltage capacitors in series employed as a voltage divider. More CCVT's are being used in voltage and energy measurements at levels of 345 to 765 kilovolts, where they have the significant advantage of costing less initially than inductive PT's in cascade. A further cost advantage of the CCVT is that its capacitor stack is also used for power line carrier coupling of telemetry, communications, relaying, and voice circuits, thus avoiding purchase of separate coupling capacitors. Also, CCVT's are noted for their greater ruggedness compared to the more fragile PT's.

No Alternatives

At ultra high voltage (UHV) levels, above 765 kilovolts, there are no workable alternatives to CCVT's because of the bulk and excessive cost of the PT's, Hillhouse points out. However, the CCVT is still a relatively unproven device compared to the PT, for which there is a record of over half a century of use and improve-

Mangan and BG&E engineer William Keagle inspect flexible high voltage lead for connecting calibration system divider to high voltage bus (left).

After preliminary calibration, the high voltage transfer standard divider is connected to 500 kV bus for CCVT calibration. BG&E engineer Carl Manger, holding flexible high voltage connection lead, directs utility personnel moving the unit.

ment. Until its long-term accuracy and stability have been proved more thoroughly, the CCVT will require periodic recalibration, he says.

New Calibration Unit

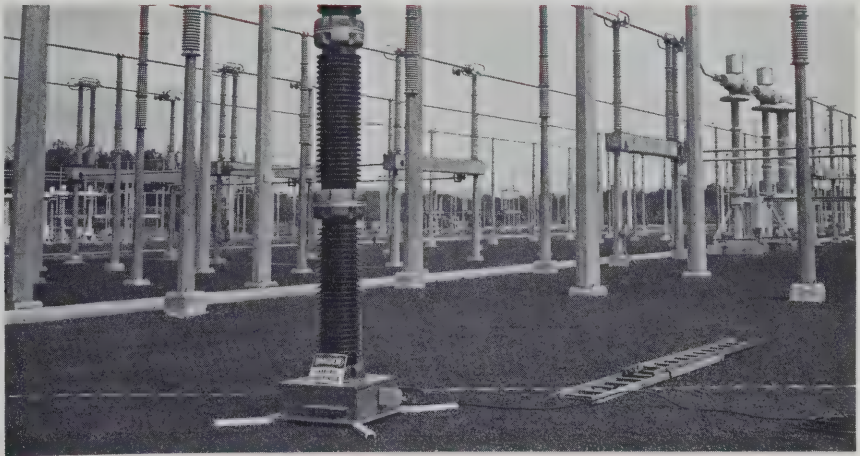
More accurate calibration of CCVT's used in revenue metering on high voltage lines will now be possible as a result of a new portable calibration unit developed by Hillhouse, Dr. Oskars Petersons, chief of the High Voltage Measurements Section, and engineer Wilbur C. Sze. The new unit, which is truck mounted, will permit accurate on-site recalibration of CCVT's at voltage levels of up to 500 kilovolts. In addition, the system, which is relatively simple to operate, is also capable of being extended to higher voltage levels as the requirement develops. The unit was developed for the Electric Power Research Institute (EPRI), in a project jointly sponsored by NBS and EPRI with the close cooperation of the Edison Electric Institute.

When used commercially by power companies, the calibration unit will be connected to the high voltage substation bus in parallel with the utility CCVT, and the outputs from the two devices will be compared to calibrate the CCVT. A truck-mounted resonant power supply is used to precalibrate the unit before it is placed on the 500-kilovolt substation line.

The NBS prototype system has been successfully field tested at the Waugh Chapel, Md., Substation of Baltimore Gas and Electric Company (BG&E) and at the Brighton, Md., substation of Potomac Electric Power Company.

According to Hillhouse, results from the field tests indicate that the calibration system has an overall accuracy better than the project goal of 0.05 percent. The system can be set up and dismantled quickly and conveniently, which minimizes any interference with the normal substation operation. As a result of these successful tests, it appears that the new calibration unit will help insure the accurate operation of CCVT's and in turn minimize errors in metering energy transmitted over the thousands of miles of long distance transmission lines and inter-network tie lines. ☐

Divider is placed in position for connection to 500 kV bus. Flexible temporary lead can be extended downward from bus at right.



Now in position for calibrating the CCVT's, the 5.4-meter tall transfer standard divider consists of three stackable capacitance modules in series. CCVT's being calibrated are at other end of the switchyard.

HIGHLIGHTS

Willenbrock to SMU

Dr. F. Karl Willenbrock, Director of the NBS Institute for Applied Technology (IAT), has resigned his post as of October 1, 1976. Willenbrock has accepted appointment as Dean of the School of Engineering and Applied Sciences at Southern Methodist University in Dallas, Texas. In addition to his deanship, he will also occupy the endowed chair of Green Professor of Engineering.

Dr. Ernest Ambler, Acting Director of NBS, has designated Dr. James R. Wright, Deputy Director of IAT, to serve as Acting Director of the Institute.

Willenbrock directed the Institute for Applied Technology for five-and-a-half years, a period which saw the establishment of the Center for Building Technology, the Center for Fire Research, and the Center for Consumer Product Technology within IAT. Other programs initiated under Willenbrock's directorship include a major effort in energy conservation and a program to evaluate for the Energy Research and Development Administration energy-related inventions worthy of support.

CBT Issues Report

A newly-issued report from the National Bureau of Standards summarizes the work performed during 1975 by NBS' Center for Building Technology (CBT).

Each CBT project is concisely summarized in non-technical language that lists the building research project by title and gives its progress, a point of contact within CBT, and the project's sponsor.

Some of the areas covered in the report include: energy conservation in buildings, communities and industry; solar energy; building economics; sensory environment; architectural research; building safety; plumbing and drainage; mobile homes; mechanical systems; and building codes and standards.

Titled "Building Technology Project Summaries" and designated NBS Special Publication 446, it is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. SD Catalog No. C13.10:446, $2.05.

NBS-6 Twice as Accurate

Tests of the latest generation of National Bureau of Standards atomic clocks, NBS-6, demonstrate that it determines the length of the second to within 8.5 parts in 10^{14} (comparable to about one second in 370,000 years).

The determination of the second to this accuracy reveals that the international atomic second, maintained by the International Time Bureau (BIH) in Paris, is too short by about 11 parts in 10^{13}.

The new NBS-6 cesium beam clock is twice as accurate as its predecessor, due to the use of its beam reversal capability, improved magnetic field stability, and the use of better techniques for directly evaluating systematic frequency offsets due to the electronic system and the microwave cavity structure.

The new clock is now part of the ensemble of clocks which generate and maintain the NBS atomic time scale at (NBS).

Pacemaker Reliability Reported

"Reliability Technology for Cardiac Pacemakers," a new report from the National Bureau of Standards, summarizes the technological problems related to assuring the reliability of cardiac pacemakers discussed in a workshop held at NBS last year.

The workshop, which was conducted as part of the Semiconductor Technology Program in the NBS Electronic Technology Division, was partially financed by the Food and Drug Administration's Bureau of Medical Devices and Diagnostic Products. It brought together for the first time representatives from the pacemaker, electronics and related communities to discuss areas of mutual concern in pacemaker reliability. An estimated 200,000 persons in the United States now rely on implanted pacemakers to regulate their heartbeats.

"Reliability Technology for Cardiac Pacemakers," SD Catalog No. C13.10: 400-28, may be purchased for $1.25 a copy ($1.55 for foreign mailing) from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Cast Iron SRM Renewed

A Standard Reference Material (SRM) for Cast Iron, first issued in 1905, has now been renewed for the eleventh time.

SRM 4k is available in chip form sized between 0.7 mm and 1.2 mm sieve openings (26 and 16 mesh). It is issued with a Certificate of Analysis for total carbon, graphitic carbon, manganese, phosphorus, sulfur, silicon, copper, nickel, chromium, vanadium, and molybdenum. In addition, analytical information is provided for several other elements.

A 150 gram sample of SRM 4k may be obtained for $43 from the Office of Standard Reference Materials, Bldg. 222, B311, NBS, Washington, D.C. 20234. □

Two New Glass Standards

TWO new Standard Reference Materials (SRM's) of importance to the glass and pharmaceutical industries and medical institutions have been certified and issued by the National Bureau of Standards.

The new glasses, SRM 622, soda-lime-silica glass, and SRM 623, borosilicate glass, are needed to insure that glass containers used for packaging and storing medical preparations conform with specifications of the U.S. Pharmacopeia (XIX Revision) and the National Formulary (XIV Edition).

The standards will be used to check test methods and to calibrate equipment for determining the resistance of glass containers to chemical attack.

Measurements leading to the certification of SRM 622 and SRM 623 were performed in a cooperative program with the American Society for Testing and Materials (ASTM). Nine qualified laboratories participated in this program under the overall direction and coordination of Frank Bacon, Chairman of ASTM Subcommittee C-14.03 on Chemical Properties of Glass. The materials for the SRM's were prepared and furnished to NBS by Corning Glass Works, Corning, New York, and Owens, Ill., Inc., Toledo, Ohio.

The price for each SRM is $75 per unit. Orders and requests for information on these and other SRM's should be directed to the Office of Standard Reference Materials, Room B311, Chemistry Building, NBS, Washington, D.C. 20234. □

Computer Program for Heating/Cooling Loads in Buildings Available

A computer program developed at the National Bureau of Standards to help engineers and architects design more energy efficient buildings is now available for general use.

The comprehensive, easy-to-use program is contained in a 398-page document titled, "NBSLD, the Computer Program for Heating and Cooling Loads in Buildings." It can be purchased for $4.60 a copy ($5.75 for foreign mailing) from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. (Order by SD Catalog No. C13.29/2:69).

Computer simulations are often used by engineers to study the thermal performance of buildings in an effort to design energy-efficient heating and cooling systems. Inaccurate load calculations can lead to overdesigned heating and cooling equipment that uses more energy and operates at lower efficiency.

The NBS computer program is based on extensive information accumulated over the past decades in various phases of building heat transfer problems and is intended to be used for the design of equipment and air conditioning systems as well as for estimates of building energy requirements.

Originally developed as a research tool, the NBS Load Determination (NBSLD) program has a number of unique features that enable the accurate determination of heating and cooling loads in buildings. It was developed by the NBS Center for Building Technology in a joint NBS-Department of Housing and Urban Development (HUD) project because most available computer programs were not suitable for analyzing building designs where nonconventional or innovative ideas on structures, heating and cooling systems, and controls are employed.

NBSLD covers some 300 variables in three categories: the weather, the building, and the way the building is operated. The computer output is presented in the form of a profile of heating and cooling loads on an hourly, daily, weekly, monthly, or yearly basis.

The program enables the merits of various building constructions and systems to be evaluated and has already been used for studies of HUD housing systems and constructions of the Defense Department and the General Services Administration (GSA) where nonconventional designs had to be evaluated. For example, using the program, NBS researchers helped design a GSA office building in Manchester, New Hampshire, that will use one-third less energy than a similar building of conventional design.

The new computer program document contains highlights of the unique features of NBSLD, summaries of various subroutines along with the detailed procedures to use them, a complete Fortran listing, and data preparation forms. □

Direct Government Intervention Would Have Little Impact on Investment in Small, Technology-Based Companies

THE flow of capital funds to small, technology-based firms might be increased by as much as 10 percent by changes in tax or securities regulations or by loan and investment guarantees to the suppliers of these funds. But direct government investment in these small firms may only displace private funds rather than increase the total flow of capital funds.

These are among the major conclusions of a comprehensive analysis of the venture capital market performed for the National Bureau of Standards' Experimental Technology Incentives Program (ETIP) by Charles River Associates of Cambridge, Mass.

The 18-month study, performed under a $300,000 ETIP contract, revealed flaws in the venture capital market that restrict the flow of funds to small technology-based firms. The venture capital market is defined as any source of funds (risk-capital) supplied to these firms. The source may be banks, private or public venture capital firms, small business investment companies, insurance companies, or pension funds.

The study showed no indications that these small technology-oriented firms (assets less than $5 million) paid higher rates of interest or returned more to their shareholders than other small firms. Nor do the venture capitalists earn higher profits than could be earned by investing in stocks or bonds.

It was estimated that there are between 400 and 600 firms active in the venture capital industry and that they supplied between $75 and $100 million annually to small technology-oriented firms in the late 1960's and early 1970's.

Reducing the tax rate on capital gains from 35 percent to 25 percent would increase the flow of funds to these firms by "at most" 10 percent, according to another estimate. It was also estimated that a liberalization of Securities and Exchange Commission Rule 144 would increase the flow of funds by "at most" 5 percent. This rule specifies a minimum holding time and restricts the rate of disposal of formerly restricted securities.

Persons wishing to obtain copies of the executive summary of the study, titled "An Analysis of Venture Capital Market Imperfections," should contact Gregory C. Tassey, Experimental Technology Incentives Program, Room A735, Administration Building, National Bureau of Standards, Washington, D.C. 20234. □

Symposium to Examine Thermal Comfort and Indoor Environments

THE impact of energy conservation strategies and new building designs on the thermal comfort of people in indoor environments will be explored during a symposium February 11, 1977, at the National Bureau of Standards, Gaithersburg, Md.

The "Symposium on Thermal Analysis-Human Comfort-Indoor Environments" will bring together leading scientists, engineers, government officials, architects, physiologists, and manufacturers interested in how new energy conservation modifications to buildings will affect human comfort and what type of measurement technology will be required to assess these effects.

Sponsored by the NBS Institute for Basic Standards and the NBS Institute for Applied Technology, the sysposium is prompted by the increasing emphasis on energy conservation practices in existing buildings as well as new building designs that emphasize energy conservation.

Some of the practices have no effect on the thermal comfort of occupants. However, others, such as limiting the use of both cooling and installed capacity of heating, ventilating, and air conditioning equipment; lowering thermostat settings in winter; raising thermostat settings in the summer; and eliminating climate control in halls, entryways, and storerooms may have an adverse effect on occupants.

Although the effect of a given energy strategy on the total energy requirements of the buildings is relatively easy to predict, very few data are available to assess the effects of the resulting indoor climate on the comfort of occupants.

The symposium will attempt to examine these issues by identifying:

1. Characteristics of indoor climates that result from various types of energy conservation strategies.
2. Characteristics of heat stress environments such as those encountered in ships' firerooms, in machinery spaces, and in foundries.

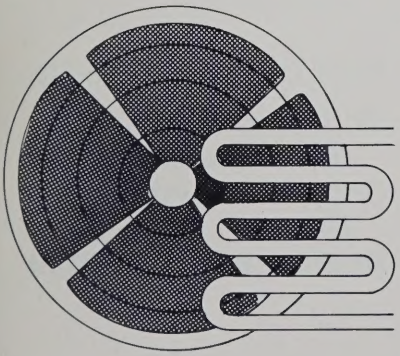
3. Research needs in the area of physiology that could ultimately result in the specification of acceptable conditions.

4. Contributions that could be made by modeling human responses to specific environments.

5. Contributions that could be made by studies of human subjects in controlled environmental chambers. Would an approach like this be acceptable or would testing in real environments be necessary? Could the conditions identified in (1) be properly simulated in the chambers currently available? What are the best methods for reducing the types of variations outlined in (1) to some "standard" test conditions?

6. What new demands are placed on the field of instrumentation in order to correctly assess and characterize environments?

Additional information about the symposium may be obtained from the symposium co-chairmen: Dr. B. W. Mangum, B122 Physics Building, 301/921-2098 or Dr. J. E. Hill, B104 Building Research Bldg., 301/921-3512, National Bureau of Standards, Washington, D.C. 20234. ☐



Dynamic Pressure Source Developed for Calibration of Pressure Transducers

THE National Bureau of Standards has developed a new pressure source for the dynamic calibration of pressure transducers.

The source, developed by NBS' Electronic Technology Division, consists of a liquid-filled cylindrical vessel, 11 cm in height, mounted upright on the armature of a vibration exciter which is driven by an amplified sinusoidally varying voltage.

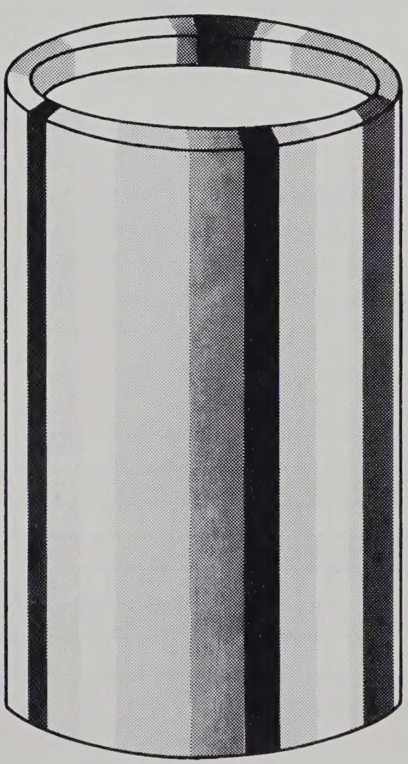
The transducer to be calibrated is mounted near the base of the thick-walled aluminum tube forming the vessel so that the pressure-sensitive element is in contact with the liquid in the tube. A section of the tube is filled with small steel balls to damp the motion of the 10-St dimethyl siloxane working fluid in order to extend the useful frequency range to higher frequencies than would be provided by an undamped system. This approach is simpler and more versatile than other damping schemes considered.

The result is a dynamic pressure source capable of generating pressure levels of up to 34 kPa over a frequency range from approximately 50 Hz to 2 kHz, flat to within ±5 percent. At frequencies below 50 Hz the pressure amplitude was limited by the displacement capability of the particular vibration exciter used. The estimated total calibration measurement error when using the source with a typical transducer is about 4 percent. This estimate is based on the knowledge of the density and weight of the liquid column and the amplitude of the applied vibrational acceleration.

A description of the new pressure source is contained in NBS Technical Note 914 which was prepared for the National Aeronautics and Space Administration's Langley Research Center in Hampton, Va.

Copies of Technical Note 914, A New Dynamic Pressure Source for the Calibration of Pressure Transducers, may be ordered prepaid for $.85 by SD Catalog No. C13.46:914 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Foreign remittances must be in U.S. exchange and include an additional 25 percent of the publication price to cover mailing costs. Order microfiche copies prepaid by NBS designation from the National Technical Information Center, Springfield, Va. 22151; the price is $2.25 (domestic) or $2.95 (foreign) a copy. ☐



Issues Involved in Converting U.S. Building Industry to Metric Explained

ARCHITECTS, engineers, building code officials, and others involved in the U.S. building industry have access to a new publication from the National Bureau of Standards that explains the issues involved in converting this industry to the modernized metric system (SI).

Titled "Metrication Problems in the Construction Codes and Standards Sector," and designated NBS Technical Note 915, the publication was authored by Charles T. Mahaffey of NBS' Center for Building Technology.

The publication begins with a discussion of SI metric units, including such issues as exclusion by building interests in other English speaking countries of "centimeter" as a preferred multiple of the base unit (meter). "Many people in the U.S. building industry are not happy with this exclusion, feeling that the centimeter represents a useful and comprehensible sizing unit," notes Mahaffey. He then lists reasons given for excluding centimeter.

"Agreements among the members of the U.S. building community regarding the identification of the SI units to be used in construction must be reached at an early date if the full benefits of the simplicity and internal consistency of SI are to be realized. To delay the development of this needed national agreement is to create a host of unnecessary problems," the author states.

The publication also discusses the desirability of introducing dimensional coordination concurrently with the metric system. Dimensional coordination is the establishment of a direct relationship between the dimensions used in the design of a building and the size of the components used in the actual construction.

Finally, the publication notes some of the organizational problems in getting all segments of the building industry involved in a commitment to metrication and dimensional coordination—and, once committed, to implementing a conversion plan in a coordinated way on a national scale.

Copies of NBS Technical Note 915 may be ordered prepaid for 75 cents by SD catalog No. C13.46:915 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Foreign remittances must be in U.S. exchange and include an additional 25 percent of the publication price to cover mailing costs. Order microfiche copies prepaid by NBS designation from the National Technical Information Center, Springfield, VA 22151; the price is $2.25 (domestic) or $2.95 (foreign) a copy. □

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